The thermal structure of lithospheric mantle beneath Japan Trench oceanward slope

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Pillow alkali-basalt outcrops were sampled at depth of 7324 to 7360 m on the oceanward slope of the northern Japan Trench during JAMSTEC (Japan Marine Science and Technology Center) R/V Kairei/ROV KAIKO cruise KR97-11, Kr03-07, KR04-08 and YK05-06. The Ar-Ar age of the alkali-basalt is 5.95 +/- 0.31 Ma and is reported as a new form of intra-plate volcanism where decompression and magmatic activity occurs off the fore bulge of the downgoing Pacific slab (Hirano et al., 2001; 2004). Several mantle xenoliths and xenocrystic olivine were observed in the basalts. Assuming P-T conditions of the xenoliths, the geothermal gradient of the downgoing Pacific slab is estimated. The thermal structure of the subducted slab is absolutely essential to elucidate a lot of geological phenomena occurring at the mantle wedge such as dehydration, magma generation and deep-focus earthquakes.

Both xenoliths and xenocrysts include abundant liquid CO_2 inclusions. For mantle-derived rocks, residual pressure in the fluid inclusions has often been used to estimate the depth where the xenolith was entrained by host magma. If the density of CO_2 in the fluid inclusions is determined, the P-T condition where the fluid inclusions were equilibrated with the host minerals can be determined using the equation of state for CO_2 and a temperature estimated from a geothermometer. Micro-Raman spectroscopic analysis allows us to estimate density of a very small amount of CO_2 by non-destructive analysis (Yamamoto et al., 2002; 2005; Kawakami et al., 2003). The density of CO_2 is estimated to be 1.2 g/cm^3. The equilibration temperature estimated from the two-pyroxene geothermometer is around 1130C. Extraporation of the density of 1.2 g/cm^3 to higher temperature indicates that the internal pressure of inclusions corresponds to about 1.3 GPa at 1130C. Such a pressure corresponds to 45 km or more in depth. The xenoliths are derived from the lowermost part of the downgoing Pacific lithosphere. The geothermal gradient determined from the P-T conditions of the xenoliths is clearly high and is not consistent with some models for thermal evolution of oceanic lithosphere (e.g., GDH-1 or CHABLIS). The anomalously high thermal gradient may have an effect on thermal structure of the mantle wedge.

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